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Re-assessing the navigation impact of draining the Fens in the seventeenth century

Michael Chisholm

Draining the Fens in the seventeenth century was an enterprise of national economic significance. The literature it spawned has been considerable and, concentrating mostly on the land drainage, generally paints a negative picture of the effects on navigation. On the other hand, there is clear evidence that traffic over the waterways continued after the drainage works had been completed and economic historians, and historians of transport, have accepted the fenland navigations as remaining viable from the mid-seventeenth century until the coming of the railways some two centuries later. The present paper concentrates on the Ouse between Denver and Earith, and the tributary rivers, systematically examining the available information regarding the 'before' and 'after' condition of the rivers, and the commercial traffic therein, something which has not previously been undertaken. The claims for the adverse impact on navigation do not stand up to this scrutiny, requiring an adjustment in our thinking about the drainage enterprise.

Following a largely abortive attempt to drain the Fens in the 1630s, a fresh start was made following an Act of Parliament in 1649. The scheme adopted was that of the Dutchman, Cornelius Vermuyden, and is well described by Darby (1956) among others. Several rivers rise in the uplands which surround the low-lying Fens and traverse what was swamp and reed on their way to outfalls in the Wash. Vermuyden’s scheme had some fundamental components. By shortening rivers, their gradient would be increased and consequently upland water would be discharged to the sea more quickly than hitherto. He dug the New Bedford River parallel to the Old Bedford River, with the space between designed to hold winter flood waters: the washes. To effect the diversion of the Great Ouse at Earith down the New Bedford River, a sluice was built at Hermitage, and other sluices were constructed to keep out the tides, the most important of these being the one across the Ouse near Salters’s Lode, now known as Denver Sluice (Fig. 1). The scale of this nationally important enterprise is indicated by the fact that the sponsors – the Adventurers – would get 95,000 acres (38,445 hectares) of land in recognition of their investment.

Post-medieval navigation on the Ouse above Earith has been well documented (Summers 1973; Willan 1942; Wood 1992), but there has been no general study of the Fens as a whole, or of the Ouse above Denver Sluice to Earith and the tributary rivers. The mainstream literature on inland navigation has relatively little to say about the Fens since the medieval period; this may be because the area has seemed to be something of a backwater, there having been no modern canal construction. As a result, assessments of navigation have been much influenced by the literature on the seventeenth century draining of the Fens, in which it is common to portray the drainers as uninterested in navigation matters and making little or no provision for vessels, and that their works were in fact prejudicial to the use of the waterways for commerce. Chisholm (2003, 2005, 2006) notes a number of authors who have adopted this negative view of the impact of drainage on navigation, including Darby (1956, 1983) and – with special reference to Denver – Summers (1973, 1976).

One author, not previously mentioned by Chisholm, states that ‘there was far more [water carriage] prior to the draining of the Fens’ (Cox 1914, p. 10), and another says of the fenland rivers in the eighteenth century that they ‘were barely navigable’ (Hills 2003, p. 34). Not uncommonly, authors have assumed that when Denver Sluice was built across the Ouse in 1652 no lock facilities were provided, and that it was only when it was re-built in 1748–50, following its partial destruction in 1713, that a lock was incorporated (e.g. Gerrard 2003, pp. 103–4; Paget-Thomlinson 1993, p. 143). It has even been asserted that ‘the old Fen sluices were intended solely to facilitate drainage’ (Gaches 1906a, p. 266), a view consistent with Skempton’s assessment of Vermuyden as a river engineer ‘not concerned with river navigation’ (Skempton 1953, Table IV).

Compiling a later work on civil engineers, Skempton changed his mind and recognised Vermuyden’s provision for navigation (Skempton et al. 2002), and the papers by Chisholm noted above have begun a more general process of re-assessing the relationship.
between drainage and navigation in the seventeenth century. The sluices built across navigable waterways included locks for the passage of boats, and there is clear evidence that traffic continued to ply to inland destinations such as Cambridge. Economic historians have certainly taken the view that draining the Fens resulted in a substantial increase in production and trade (e.g., Rich & Wilson 1967), and there is no evidence to suggest that the port of King’s Lynn (henceforth Lynn) suffered on account of disrupted inland navigation after 1652 (Barney 1997, 1999). The general literature on inland navigations pays little attention to the Fens but does not suggest that the fenland waterways became less useful as navigations after the sluice at Denver and the other works had been completed (Duckham 1983; Dyos & Aldcroft 1969; Paget-Tomlinson 1993; Priestley 1969).

So why were fenland navigation interests so hostile to the drainage enterprise? Was there a real basis for their concerns and their desire to have the drainage works, including Denver Sluice, removed? Is it the case, as Paget-Tomlinson (1993, p. 143) and Parker...
Allegations regarding the prejudice to navigation post 1652

Allegations about the prejudicial impact of the drainage works upon navigation can only be understood in the context provided by the way the drainage scheme was funded and by contemporary ideas regarding the nature of changes in river regimes as a consequence of the structures that were built. Passage through the locks at Denver, Hermitage and elsewhere incurred no tolls, since the legislation was predicated on the idea that taxes on the improved lands were managed for the benefit of drainage. There were also vociferous complaints about the ‘choking’ of the Ouse below Denver.

Badeslade (1766) documents these general concerns and provides a good deal of detail supporting the view that conditions for navigation deteriorated after 1652, when Denver Sluice was completed. Most of the allegations in the modern literature about the injurious effects of the drainage works on navigation can be traced to this volume. Unfortunately, many scholars have not recognised the polemical nature of Badeslade’s work, which was first published in 1725 when there was an intense debate about the desirability of re-building Denver Sluice following its partial collapse in 1713.

In his preface, Badeslade categorically asserts that it is the tides which keep a river open for navigation. Consequently, he was not in favour of Vermuyden’s approach to land drainage, preferring the surprisingly hardy rival ideas espoused by Westerdyke, who advocated keeping the rivers on their ‘natural’ courses, making them narrower and embanking them, with no sluices. It is not that Badeslade was ‘on the side of those, such as the port of King’s Lynn, concerned with navigation’ and therefore in opposition to drainage (Darby 1983, p. 99); Badeslade had his own view of how drainage and navigation should be best combined. To that end, he assembled testimony which served to show that Vermuyden’s scheme was inappropriate, comparing the good conditions which existed for navigation before the drainage was completed with the much worsened circumstances afterwards. This documentation has been surprisingly influential in shaping opinions about the impact of the drainage works on navigation.

Badeslade’s starting point is the situation prior to 1652, described in the following terms:

The inland navigation was so good in all the rivers, viz. Ouse, Stote, Brandon, Mildenhall, and Grant, that keels could sail with forty ton of freight 36 miles from Lynn towards Cambridge at ordinary neap tides; and as far as Huntingdon with fifteen ton of freight. And barges with ten chaldron [about 13 tons] of coals could sail up Brandon river to Thetford: and as far in proportion up the rivers Mildenhall, Stote, etc. (Badeslade 1766, p. 1).

These river names, and their modern equivalents, are shown in Fig. 1. For the meaning of ‘keel’, and also for the conversion of freight figures to approximate tonnages, see the Appendix. Thetford was the historical head of navigation on the Little Ouse (Brandon), so Badeslade is saying that loads of about 13 tons could reach the head of navigation on the other tributary rivers. An ordinary neap tide is the lowest high tide, which occurs twice in a lunar month. Hence, it is evident that Badeslade is saying that under the least favourable circumstances the rivers were easily navigable as described and he might have claimed that he was being conservative in his portrayal of the pre-1652 situation.
Badeslade (1766, pp. 53-7) goes on to document the fears for the future and the alleged actual detrimental effects of the drainage works. In 1650, Lynn petitioned against the construction of sluices and was supported by the Corporation and the University of Cambridge. Other petitions in the early 1650s were lodged as follows:

1. Lynn. That the freight capacity of the inland waterways had been halved and Denver Sluice should be removed.
2. Brandon (Little Ouse). Keels could formerly reach Brandon bridge with 20 chaldrons (about 27 tons) of coal but now only lighters could get that far, with smaller loads. Navigation was said to be 'almost quite useless'.
3. Thetford (Little Ouse), Mosses Russell and Rudham. Formerly barges could bring up to 15 chaldrons of coal (about 20 tons) to the town but now not more than three chaldrons (about four tons).
4. Cambridge (Cam). Freight costs raised by more than one third.

Nevertheless, the sluices remained in place. After several further attempts in vain to have Denver Sluice removed, Lynn amassed further testimony, including that of a Mr John Atteson, to the effect that, prior to the construction of Denver, 'large barges and vessels' could regularly and easily reach Cambridge with 26 to 30 chaldrons of coal (about 35-40 tons), whereas only 'flat-bottomed' lighters could now pass that far up river, and even then with great difficulty and carrying only 8-10 chaldrons (about 11-13 tons) (Badeslade 1766, pp. 61-2; see also Elstobb 1793, p. 211). Concerned about 'obstructions' in the port and the 'river belonging' (Borough of King's Lynn 1696), Lynn petitioned Parliament in 1696 for the removal of Denver Sluice, submitting a Bill for this purpose which elicited 12 other petitions, some in support of and some against Lynn's plea. Petitions supporting Lynn on navigation grounds were lodged by:

Stoke Ferry; Wissey;
Brandon and Thetford: Little Ouse;
Mildenhall and Bury St Edmunds: Lark;
Cambridge Corporation: Cam;
Cambridge University (who were equivocal): Cam

The general complaint was that, before the drainage works had been undertaken, 'vessels of great burden' could use the rivers, whereas now 'boats of the smallest burden' had great difficulty. The petitions are unspecific regarding the sections of river where the alleged defects were occurring. With the exception of the University, they were united in asking for Denver Sluice to be removed.

Three of the 12 petitions can be discounted in the present context because the petitioners were alleging the 'drowning' of their lands and not the impairment of navigation. The remaining four petitions all supported the retention of the sluices, Denver included. Two of these originated from Huntingdon, which had gained from the construction of the New Bedford River: one from the Corporation of the Bedford Level (the drainers); and one from the Dean and Prebendary of Ely Cathedral, Ely being located on the now non-tidal Great Ouse.

The negative view of the impact of the drainage works boils down to four propositions: first, that the outfall below Denver had silted up; second, that above Denver the Great Ouse and its tributaries had lost the benefit of the tides; third, that the water levels in the rivers were lower than they had been before drainage; and finally, that the change in fluvial regimes had caused silting of the river channels. The extreme case cited is that the level of the Ouse at Harriermere, just above the confluence with the Cam, had fallen by five feet following the construction of Denver Sluice, so that whereas 'boats and barges' had previously passed, 'grass and fodder is now mown' (Badeslade 1766, p. 62).

It is this and similar material which has been used by later authors to present a gloomy assessment of the impact of drainage on the navigability of the Ouse. It has seemed plausible that water levels on the Ouse would have been lowered by the drainage works and several authors have accepted that this would have caused problems on the tributaries (Boyce & Russell 1977, p. 326 fn; Chisholm 2003, p. 186; Dymond 1985, p.235; Gaches 1906b, p. 360).

To what extent are the 'before' and 'after' claims made by Badeslade supported by other evidence? This is the question to which we now turn.

The pre-1652 state of the rivers: general

Before considering the condition of the Great Ouse and the individual tributaries before and after 1652 in the sections below, there are some general points to note about the waterway system before the drainage works were undertaken. The pre-existing drainage pattern of 'natural' and artificial navigable waterways was much more complex than it was after Vermuyden's engineers had completed their work. Furthermore, prior to these engineering works, the waterways had been constantly evolving and changing, and these changes had continued into the first half of the seventeenth century (Astbury 1958; Fowler 1934).

All was not well with the waterways in the early part of the century. Three documents dating from 1617 and 1618 are reproduced by Wells (1830, vol. 2), which together indicate the seriousness of the problems and the difficulty of finding solutions that would respect the needs for land drainage while at the same time maintaining the existing navigations. A Commission of Sewers met in Huntingdon in February 1617, with representatives from six counties. In the light of surveys conducted in the preceding five months, they decreed that most of the main waterways were to be 'dyked, cleansed, formed, scourwed, and perfected, to the ancient breadth and to the old bottome' (Commission of Sewers 1617, p. 44). All of this work was to be undertaken by the landowners. Nowhere in the document is there any reference to navigation, though a reasonable inference would be that deepening the channels would facilitate rather than hinder navigation once the work had been completed. In the
event, it seems that little was done (Dugdale 1772, pp. 403–4; Summers 1976, p. 60).

However, both Atkins (1618) and Edmond (1618) note that dredging out shallow sections of rivers to improve the discharge of water for drainage purposes could have serious implications for navigation, primarily at times of low flow. Both authors record that the Vice-Chancellor of Cambridge University was against the dredging of the shallows, for fear that there would be inadequate water in much of the rivers’ channels. Whereas Edmond proposed no dredging of shallows, Atkins proposed a more subtle approach. On the Great Ouse itself, he opined, the flow was sufficient to maintain a navigable depth and dredging could be undertaken, whereas the sandbanks and shallows on the Cam should be retained because otherwise the natural flow of the river would be inadequate for the passage of boats. Perhaps the single most important proposal was made by Atkins: the real need was to construct ‘navigable sluices’, i.e. locks, on the River Ouse, implicitly from near Ely and up river therefrom. In his view, this would simultaneously improve land drainage and maintain the navigation. However, he judged that the cost of building and maintaining such sluices meant that this solution was unlikely to be adopted (Atkins 1618, p. 94).

It seems that the general size of vessels on the fenland waterways was quite small in the sixteenth century. A special survey in 1566 recorded the details of river vessels at three towns in the administrative area of the Isle of Ely. At March, the freight capacity of the ‘greate bates’ ranged from one to two ‘carte lode’ (about 1–2 tons); at Ely, the barges could carry six to eight ‘carte lode’ (about 6–8 tons); while at Wisbech, the freight capacity ranged from three to 12 ‘tons’ (Ely et al. 1909, p. 95). The figures do not include vessels based at Lynn and elsewhere, so we cannot be certain that they are representative; nor do we know whether, in the century to 1652, the size of vessel stayed constant. Nevertheless, these figures, in combination with the other evidence mentioned above, imply that one must be doubtful about Badeslade’s statement that ‘inland navigation was so good in all the rivers’. Nevertheless, the rivers were the highways of the Fens.

**River Great Ouse, Denver-Hermitage**

*Pre 1652*

In 1608, the Commissioners of Sewers resolved that the Ouse from Harrimere was to be straightened and deepened. The depth from Harrimere to Stuntney Bridge (presumed to be Ely Bridge) was to be four feet, while from there to Littleport the depth was to be five feet (Gaches 1903, pp. 197–8). The intention was to aid drainage; the needs of navigation were ignored. However, this 1608 resolution – which was not executed – indicates that there were parts of the river with significantly less water than the depths specified.

Dugdale (1772, pp. 380–1) records that in July 1605 there was a section of the Ouse in Ely with only 14 inches of water, and that below the town there were some ‘Hards’, or shallows, where the depth was no more than 18 inches or two feet (Fig. 2). These depths would have been inadequate for the standard lighters that became common in the seventeenth century; they could carry 25 tons when fully laden, drawing 3.5 feet of water, and required 12 inches when empty (Clark 1957, p. 212; Wilson 1972, p. 6). However, the summer of 1605 was exceptionally dry, so this record cannot be taken as representative of summer conditions. The more normal situation in the early seventeenth century seems to be that noted by Atkins: he states that the Hards below Ely always had sufficient water for ‘lighters and flat bottomed boats to pass fully laden’ (Atkins 1618, p. 93). However, he does not specify the size of craft to which he refers and he says nothing about the shallows in Ely itself. Here there was less

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*Figure 2. Ely 1810. Note the horse wading, the use of poles and the evident shallowness of the river.*

(Cambs Collection Q.B. J10 4250)
water and fully laden craft might not necessarily have had enough water even if they had negotiated the Hards unless they were quite small craft, as indicated by a 1654 pamphlet, the author of which states that, before the drainage works had been undertaken and after, an Ely-based lighterman made round trips from Lynn to Cambridge ‘commonly with five tun weight’ (Anon. 1654 p. 22). Even so, the same author goes on to say that, before 1652, ‘in summer time the neap tides were not high enough, to help their lifters over the gravel below Ely’. It does seem to be the case that, at times of low flow (normally in the summer), water levels at Ely could be low enough to make the passage of laden vessels difficult or impossible, which would have necessitated waiting for higher water or for trans-shipment to achieve lesser loads.

There were additional shallows, or ‘stops’, above Ely, at and above Harrimore, just beyond the Cam confluence:
The other stops which be in Ouse from Harrimore upwards to St Ives, especially those about Streatham (which of all other the worst) be gravells made over the river of sett purpose by cart to lech over their fodder and hay out of the fennes: these gravells being 3 or 4 in number, do great harne to the drayning, and cannot be said to be anything beneficial to the navigation (Atkins 1618, p. 94).

Some of these causeways are shown on later maps (e.g. Bowen 1751; Watson 1827; map facing p. 20). However, Streatham Gravel is a natural feature, not man-made; at this point, in the early seventeenth century, the water was only two feet deep (Fowler 1933, p. 122), with the implication that loads no greater than about 10 tons could pass, whereas Badeslade gives a figure of 15 tons.

Badeslade refers to keels with 40 tons sailing 36 miles towards Cambridge (1766, p. i). The point which they reached can be identified with some precision. Before the Ouse was diverted northward at Ely towards Littleport in 1830, it ran via Prickwillow, its course marked by Middle Fen Bank. For almost exactly one mile, this embankment is absolutely straight, signifying an artificial cut. At its eastern end, this straight section is marked by the Old Plough, formerly a riverside inn and now a private residence (grid reference TL 575 812). The river used to follow an older channel, from a point south of Ely, past Stuntney and Quanae to the Old Plough; this old channel is a clearly visible roddon on the 1:50,000 geological map, sheet 173 (Fig. 3). The straight cut west of the Old Plough was made in the twelfth century (Gardiner 1993, p. 35), to facilitate the building of Ely cathedral. This meant digging through the small exposure of rather hard Kimmeridge clay on which the Old Plough stands, giving rise to the Hards identified by Fowler (1934, p. 22).

These shallows are clearly shown in Elstobb’s (1770) river profile, at a distance of 36 miles and five furrows from the Old Bar Beacon, downstream from Lynn, at a point just under one mile from the Overfall Mill, which marks the western end of the straight embankment (TL 561 804) mentioned above. Elstobb identifies these shallows as ‘near the Tild House’; if tild is an abbreviation of tiled, this would describe the Old Plough, which is indeed nearby.

Recent excavations at Broad Street in Ely have revealed harbours in the form of cuts perpendicular to the river, the cuts ranging in width up to somewhat over 13 feet (4 metres), suitable for vessels no bigger than lighters capable of carrying 15–25 tons. These harbours were in use from the fourteenth century into the sixteenth (Cessford, Alexander & Dickens, 2006). We do not know whether other harbours and quayside facilities could accept larger vessels, but the inference is that keels with 40 tons were not reaching Ely.

**Post 1652**

Despite complaints by those with interests in navigation, we know that commerce along the Ouse from Lynn continued and even flourished after Denver Sluice was built. This will be clear from the discussion about the Cam, Little Ouse and Lark later in this paper. Most histories of Ely say little or nothing about daily commercial life, but we know that there were quays from at least the late fourteenth century or early in the fifteenth (Cessford, Alexander & Dickens, 2006), and Carter (1753) describes the importance of the Ouse for the town. From the *Victoria County History* (VCH 1967, p. 43), it is clear that there was no interruption to or serious worsening of Ely’s river communications after 1652; indeed, from the seventeenth century, coal was unusually plentiful and cheap. Furthermore, it is known that boat building was an important industry in the town and flourished after the middle of the century (L. Turner Pers. comm. 2005). Two maps of Ely, dating from the early 1660s, show vessels on the river. The three craft depicted by Hermannides (1661) are all lighters, whereas Hondius (1662) shows two lighters and three larger vessels that look like sea-going craft, all three of which are downstream of the lighters. As noted in the Appendix, it is unlikely that sea-going ships penetrated up the Ouse, so Hondius may be portraying the keels which could reach the Hards below the town, with trans-shipment into lighters.

The standard lighter on the Ouse system (Fig. 4) was capable of carrying 25 tons when fully loaded, for which 3.5 feet of water would be needed (Clark 1957, p. 212; Wilson 1972, p. 6). So the fact that trade continued after 1652 implies that something near this depth of water was available most of the time up to and above Ely. That being the case, it is manifest that Badeslade’s assertion that water levels at Harrimore fell by five feet after the drainage works were completed cannot be true. Given that the diversion of the Ouse at Earth down the New Bedford River should have reduced levels in the river to Ely and further north, how was a navigable depth maintained?

A seemingly obvious solution would be the construction of a lock or sasse downstream of Ely, and there is clear evidence of the intent to do so. Jonas Moore worked with Vermuyden as the Surveyor for the Fen drainage project. Moore published a map of the Fens, at a scale of two inches to the mile, first
Re-assessing the navigation impact of draining the Fens in the seventeenth century

Issued in c. 1658 (Willmoth 1993, pp. 114-15). This map shows a major lock structure, one mile long, as depicted in Fig. 3. The feature identified as Russhill Clow would have been a dam or weir across the river maintaining the upstream water level, with the lock shown by the traditional ‘>‘ symbol identified by the word ‘sasse’. The lock would have been very near the building now known as the Old Plough, just downstream of the Hards noted above. But this sizeable piece of engineering work was not undertaken.

It is well known that cartographers have included and continue to include future developments on their maps partly in the hope of prolonging their currency as up-to-date documents. In that context, and even in the absence of other evidence, Moore’s map may be taken as clear evidence that a lock was envisaged just below Ely. But there is also other evidence, the earliest being a pamphlet which refers to the existence of ‘the sasse at Russhill’, whence lighters plied to Cambridge (Anon. 1654, p. 20). Moore’s map was re-issued from the same copper plates posthumously in 1684 and the following year a slim history of the Fens was published, ostensibly by Moore, in which there is reference to the ‘brick sluice at Prick-willow, with the Weare Dike thereof’ (Moore 1685, p. 53; see Willmoth 1993, p. 104 fn). Finally, and most significantly, an account book records a salary payment for ‘Nicholas Knowles sasskeeper at Rossill and the stopp there’ (Cambridgeshire Record Office 1659–60, p. 26; Palmer 1938, p. 72). Presumably, the ‘stop’ would be the clow depicted by Moore, no doubt on the principle that the whole structure would be under one management. The payment was for the year to Michaelmas 1659 and is listed with payments for other sasskeepers, including at Hermitage and Denver Dam. There can be no doubt about the intention to build a lock downstream of Ely. The Russhill that Moore depicted no longer exists, the Gault and

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**Figure 3.** The Great Ouse in the vicinity of Ely, showing the lock that was intended but not built. Redrawn from Moore (c. 1658), simplified and with some additions identified in italic.
Kimmeridge clays having been removed to form what is now known as Roswell Pits (Holmes & Rouse 1973, p. 43). The hill is recorded as Roueshil in 1221 (Reaney 1943, p. 220). The lock that was intended was never constructed. A likely reason would have been shortage of funds, but this could only be a partial explanation, because we know that navigation on the Ouse was maintained. So how was this done? There are passing references in the literature to the management of Denver Sluice to control water levels in the river but this is usually framed in terms of the interests of navigation being given low priority, to the annoyance of the traders. There has been no systematic study of which the author is aware that examines the realities of the water management regime. However, Golborne’s report of 1791 is illuminating (pp. 37–8). This report was written in the context of proposals for the Eau Brink cut, to shorten the Ouse below Denver Sluice. It was generally believed that the effect would be to reduce water levels on the seaward side of the sluice by four feet, which would have consequential effects on the Great Ouse above. Golborne argues that, were this to be a problem for navigation, the solution would lie in timing the closure of the outfall gates of the sluice so as to maintain the requisite water level. He suggests that this would maintain levels to beyond Ely but that a lock might be needed to ensure an adequate depth to Clayhithe (see also Kinderley 1751, p. 58).

If a regime of this kind could be achieved with the sluice as re-built in 1748–50, might it have been possible with the original 1652 structure? A recent assessment of Vermuyden’s work is categorical that the answer is ‘yes’. At Denver: Vermuyden built a 24 ft wide ‘double sasse’, that is, a navigable sluice with doors to keep out the tides and another set of doors to maintain the River level for navigation from King’s Lynn up to Ely and places beyond (Skempton et al. 2002, pp. 745–6).

This assessment lends credence to the claim made by the Corporation of the Great Level of the Fens (1696), in response to the Bill presented to Parliament by Lynn for the removal of Denver Sluice, that the ‘fresh doors’ enabled water levels to be maintained to Cambridge, Norfolk and Suffolk more reliably than hitherto. Somewhat over one hundred years later, Elstobb (1776) found about three feet of water at the Hards, just upstream of the Old Plough, though another profile recorded substantially less (Bower 1810). Nevertheless, we do know that there were some problems with parts of the Ouse/Cam system at the end of the eighteenth century and early in the nineteenth. Both Golborne (1791) and Mylne (1792) identified the need for an additional lock somewhere below Clayhithe because, at least seasonally, there was too little water downstream thereof, and Gooch (1811, p. 28) referred to the variation of river freight charges according to the amount of water.
The partial destruction of Denver Sluice in 1713 provides interesting confirmation that it had not been the impediment to trade that had been portrayed.

Lynn and others did not find that conditions on the river improved with the re-introduction of tides and the picture recorded by two travellers is instructive. About a decade after Denver Sluice had been built, Schellincks in 1662 commented favourably on Lynn's ability to provide 'several counties around with grain and coal' (Exwood & Lehmann 1993, p. 134). Some 60 years later, after the sluice had ceased to function, Defoe waxed rather more lyrical about Lynn's inland trade in a much quoted passage from his travels in the 1720s (Cole & Browning 1962, p. 73). With or without the sluice, trade continued much as it had previously, but the practical circumstances facing the watermen were different.

**River Cam, including Stourbridge Fair**

*Pre 1652*

Despite the existence of a sandbar at the confluence of the Cam and Ouse, Atkins in 1618 considered that the Cam presented no problems for navigation except for the section between Clayhithe and Cambridge, where some 'sand beds' and 'shallows' existed:

> If they be removed the passage would be the worse, by means of the water which is limited by the going or not going of the mill [in Cambridge] would when the mill stands fall so fast away as there would not be left any store sufficient for navigation; so as the defect is in the want of water from Cambridge; which though these gravells hold up what they can, except the mills go, none but small boats can pass: and sith the water of Cambridge river cannot in any way be increased by adding of more, men must fashion their vessels to the water, and not the water to every vessel (Atkins 1618, pp. 934).

At this time, there were in fact three mills in Cambridge (Stokes 1910).

From this account, it appears that, if keels with 40 tons were able to negotiate the bar at the entrance to the Cam from the Ouse, they would have been able to sail further than the one or two miles which would take them 36 miles from Lynn as stated by Badeslade. Consequently, we may be doubly confident that Badeslade was using the Old Bar Beacon as the point from which to measure the distance to the head of the navigation for keels with 40 tons, and not the haven at Lynn. We also have confirmation of the improbability of sea-going vessels reaching Cambridge.

Although the Cam near the head of navigation at Cambridge was not a trouble-free river, it had for several centuries been an important commercial artery for the town, and so continued in Atkins' time. Stourbridge Fair, held annually in September, was established by Charter in 1211. Situated on what is now known as Stourbridge Common, a little downstream from Cambridge, and adjacent to the Cam, the Fair quickly became one of western Europe's leading fairs (Rogers 1866, pp. 141-4). River access to Lynn was vital and we know that in 1551 there was a dispute with burgesses of that town regarding 'the dockage of vessels and keels in Stourbridge Fair time' (Reeve 1932).

We know that the Fair was flourishing at the time Camden wrote Britannia in the late sixteenth century, he describing it as 'the greatest faire of all England' (Camden 1610, p. 489). As with commerce in general, Stourbridge Fair fell on hard times in the early to mid-seventeenth century. As Caraccioli said, 'The disastrous reign of Charles I ... put a stop to all commercial intercourse in the kingdom, and reduced Stourbridge Fair to the lowest ebb' (1773, p. 35). In addition, the Civil War was also a difficult time for normal commerce. But once the conflict was over, the Fair again flourished. There was a 'goodly and full fair', as in former peaceable times, as early as 1644 (Walford 1968, p. 122).

From numerous accounts, it seems quite clear that the fortunes of the Fair depended on political circumstances and the vagaries of the plague, and not upon changes in the state of the Cam and navigation to Lynn. This conclusion reinforces the inference that can be drawn from the annual price of coal purchased by King's College Cambridge, tabulated by Thorold Rogers (1887) and presented in graphical form by Chisholm (2006). Comparison of prices in Cambridge with less continuous information for London and wholesale prices at Newcastle-upon-Tyne provides no evidence to suggest any long-term increase in the cost of shipping coal to Cambridge during the first half of the seventeenth century. So it seems safe to conclude that circumstances on the Cam were reasonably stable for navigation, with lighters and barges able to reach the town despite the difficulties noted by Atkins. On the available evidence, it seems reasonable to accept Badeslade's contention that vessels with 10 chaldrons (about 13 tons) of coal could reach the head of navigation. On the other hand, taking account of circumstances on the Ouse, which have already been discussed, it seems unlikely that the 1696 Bill presented to Parliament by Lynn could be correct in stating that vessels with 26 to 30 chaldrons (about 35-40 tons) could easily and regularly reach Cambridge.

The University and Corporation of Cambridge were fearful regarding the probable adverse impact on navigation which would be the consequence of the drainage plans proposed in the first half of the seventeenth century, and were vigorous in their opposition. The reasoning is summed up by Sweeting:

> It is clear that it was believed [by the University] that the Cam would become so low and sluggish as 'to be useless' (1894, p. 219).

*Post 1662*

A history of Cambridge by Thomas Fuller, a respected clergyman and historian, was published in 1665, shortly after the Fen drainage works had been completed, in which he sets out in clear tabular form the arguments that had been advanced against Vermuyden's project before it was completed and the counter arguments in favour. One of the issues discussed is the fear that had been felt in Cambridge...
that navigation would be halted. He then proceeds as follows:

I confess Cambridge ever looked on the draining of the Fens with a jealous eye, as a project like to prove prejudicial unto them. ... But it seems Cambridge was then more frightened, than since it hath been hurt, now the project is effected.

The clearest complaint I hear of is this, that the country hereabouts is now subject to a new drowning, even to a deluge and inundation of plenty, all commodities being grown so cheap therein. So hard it is to please forward spirits, either full or fasting (Fuller 1840, p. 149).

Fuller then discusses, and dismisses, the notion that the three recent drought years had been occasioned by draining, commenting that the air in Cambridge had become much better. Although he does not explicitly comment on the impact of the drainage scheme on river navigation, the clear implication of his text is that no particular problems had arisen, an impression which is confirmed by other evidence (Plate 4).

A chronological account of Stourbridge Fair mentions the 1649 Act for draining the Fens, saying of the University and Corporation that in 1653 they 'justly petitioned Parliament' on the adverse navigation effects arising from the elimination of the tides (Walford 1668, p. 122). However, Walford does not include any further comment on navigation issues, not even mentioning the 1702 Act for creating a statutory navigation on Clayhithe to Cambridge. Several accounts testify to the continuing importance of the Fair after 1652. Caraccioli (1773, pp. 36–7) makes mention of the Fair in 1660, that the Restoration in 1660 the Fair resumed its former importance. Walford (1668, p. 127) records that in 1696 the Fair was 'a place of large commerce', an assessment confirmed by a visitor at the end of the century, who said of the Fair that it 'was supposed the largest, and best stored with all kind of wares and commodities' (Brome 1707, p. 55). A few years previously, another visitor to the Fair described the river as being 'thick set with boats for a mile in length with all sorts of provisions', noting the 'vast heaps of coal' on the river bank (Baskerville 1681, p. 273).

These contemporary reports leave no doubt that the Fair flourished in the latter part of the seventeenth century, and that the river was a vital factor for its success. There is no hint that draining the Fens had had an adverse impact, which implies that river navigation had not been prejudiced, a conclusion which is confirmed by other visitors to Cambridge. Magalotti's account of his travels was first published in Italian in 1669; he noted that the Cam was navigable 'for small boats of burden' (Magalotti 1821, p. 230). Three years later, a Frenchman noted that 'barques de la mer' could be seen in the middle of Cambridge, along the great quay (Jouvin 1672, p. 517). The two foreign travellers provide no hint that the town had recently been affected by worsened conditions for navigation. This evidence confirms the inference drawn by Chisholm (2006) from the annual data on the price of coal purchased by King's College in the second half of the seventeenth century. Jouvin's phrase could refer either to small sea-going craft or to small vessels from as far away as the sea, i.e. Lynn. As will be explained below, the latter interpretation seems to be the more probable (see also the Appendix).

Confirmation that the river below Clayhithe was fully navigable in the second half of the seventeenth century is provided from the villages that skirt the eastern edge of the Fens. Lodes or canals, more probably cut in late Saxon or medieval times than by the Romans, link them to the Cam and hence to the Ouse river system, providing trading links which allowed the settlements to thrive as commercial centres from the medieval period to the seventeenth century and later (Gardiner 1993, pp. 36–7; Hall et al. 1996, p. 112; RCHME 1972; VCH 2002). It seems probable that the Burwell and Reach lodes were substantially re-modelled in the 1650s and 1660s by the Commissioners for the Bedford Level, i.e. those responsible for the drainage works, for both drainage and navigation purposes. The Commissioners did the same thing for Soham Lode, which enters the Ouse directly. Although Reach was in decline by the sixteenth century (Taylor 1995, p. 269), both Burwell and Commercial End at Swaffham Bulbeck prospered in the second half of the seventeenth century. The hythe at Burwell, which is known to have existed since the 1480s, was probably enlarged following the cutting of a new lode in the second half of the seventeenth century (Franklin 2005, p. 170).

Commercial End superseded Swaffham Bulbeck, further up the lode: the fine Merchant's House, noted in Pevsner's Buildings of England (1970), was built in the late seventeenth century. Recent owners have carried out extensive restoration and confirmed that the house stands on the site of a smaller but nevertheless substantial building, one external wall of which has been incorporated (L & Benvington Pers. comm. 2005). Adjacent to the house were a quay and substantial commercial buildings of various dates, some of which survive. When the trading business was auctioned in 1824, the sale particulars stated: 'The mercantile concern has been established upwards of two centuries' (Cambridgeshire Record Office 1824). Clearly, when the present house was built at the end of the seventeenth century it was an enlargement based on an existing, and thriving, business. This would not have been possible if the navigation had been impaired by the drainage works undertaken by Vermuyden.

Badeslade (1766, p. 47) assumes that the legislation passed in 1702 (1 Ann. St. 2. c. 11) to create a statutory navigation on the Cam proves that the drainage works had been prejudicial to commerce on this river. This inference is mistaken. The fact that half a century was allowed to pass after Denver Sluice was constructed suggests that there was no disaster for Cambridge. Indeed, the Corporation and the University had resolved in 1699 to seek Parliamentary approval for a statutory navigation, but took no action for somewhat over 20 years. The 1702 Act applied to the river from Clayhithe to Cambridge, precisely the section identified by Atkins in 1618 as being difficult for the passage of boats. The title of the Act includes
reference to making the river 'more navigable' and the Conservators moved quickly to construct pound locks. Four existed by 1708 or 1709, and possibly earlier (Chisholm 2003), and, so far as is known, they were built to accommodate lighter, which would have carried 25 tons fully laden. It would therefore appear that the statutory navigation was prompted by the need to rectify the long-standing deficiencies of the river, and to make real improvements, rather than by the need to remedy any supposed prejudice from draining the Fens. And whereas Badeslade records vessels with 15 tons proceeding to Cambridge before 1652, it seems probable that in the early eighteenth century vessels with 25 tons could make the trip: an increase of two thirds.

The Little Ouse

Pre 1652

The upper part of the Little Ouse, from Brandon to Thetford, was problematical for vessels in the sixteenth century. In 1507/8, stone for the priory at Thetford had to be carted overland from Brandon (Dymond 1995, p. 27), and in 1529 there were anxieties about the deterioration of the river (Martin 1779, p. 111). Improvements must have been made, and by the mid-century vessels carrying between 12 and 16 loads (about 12–16 tons) could pass from Thetford to the 'main sea' (Crosby 1986, p. 79; Martin 1779, p. 121). That improvement must have been maintained, because a document concerned with marketing corn in Norfolk, dated c. 1651, clearly considered the Little Ouse to be fully navigable. The county is described as an island, bounded on the south by the rivers Waveney and Little Ouse, and on the north by the 'main sea'; consequently, on all quarters the county had an abundance of 'havens and hithes' (Thirk & Cooper 1972, p. 343). Before Denver Sluice was built, Brandon, like Thetford, 'was a water town, the inhabitants gaining their livelihood by water traffic' (Gaches 1906b, p. 360). Therefore, there is little reason to doubt Badeslade's figure of about 13 tons as the weight that could be brought to Thetford before 1652; the higher figure of about 20 tons claimed by Messrs Russel and Ruderham seems to be unlikely, and it is notalbe that Badeslade does not adopt this figure.

Post 1652

Some authors record that, prior to 1670, the Little Ouse was not navigable or was used only occasionally and that White House, near Brandon Ferry was the effective head of navigation (Clark 1957, p. 207; Hunt 1870, pp. 47, 126 fn, 127). There is a literal accuracy in these reports, but not for the reason one might expect.

We know that the river was navigable to Thetford in the years 1663–5. Roger North, scion of the eminent Mildenhall family, attended school in Thetford prior to a year of reading before he went to Cambridge University. His autobiography makes it clear that he had time at Thetford to indulge his pleasure messing in and about the river, including at least one jaunt to Brandon. Of Thetford, he laconically records: 'There was a navigable river in town' (Jessop 1972, p. 11).

The year 1668 witnessed a major sandstorm, which blocked the river. Somewhat less than a century previously, a blowout had occurred in the sandy soils of Lakenheath Warren and episodically thereafter, at times of exceptionally strong winds, the mobile sands had advanced north-eastswards towards Santon Downham, on the Little Ouse. Santon was invested by sand, there were some quiescent years, and then the storm of 1668, which is described by Thomas Wright, a Santon resident:

And the branch of the river Ouse upon which we border ... for 3 miles together so filled with sand, that now a vessel with two load [about 2 tons] weight passeth with as much difficulty as before with 10 [about 10 tons] (Wright 1668, p. 724).

The mobility of the Breckland sands has been well known among those interested in agricultural practices and the landscape ever since John Evelyn in 1677 made a comparison with the sands of the Libyan deserts (Bray 1818, p. 464). Some authors have noted the blocking of the Little Ouse in 1668 (Armstrong 1975, p. 75; Cook 1956, p. 61; Martelli 1952, p. 24). But, with only one exception known to the present author, the literature dealing with navigation has ignored the event, and even this exception tucks the reference away in a footnote at the back of the book (Boyes & Russell 1977, fn. 89 on p. 326).

Before the storm, according to Wright, vessels with about 10 tons could pass, presumably on their way to Thetford, but the passage was difficult. Even allowing for the uncertainties about tonnages, it would seem that there may have been some deterioration of the river from the pre-1652 figure of about 13 tons given by Badeslade. But the claim by Messrs Russel and Ruderham that the navigation had been reduced to cargoes of about four tons on account of the draining of the Fens cannot be sustained. The catastrophic change had nothing to do with the Fens, and everything to do with the mobile sands, which in turn were probably due to the combination of land use (rabbit 'farming'), desiccation and other climate changes associated with the Little Ice Age of the seventeenth century.

Shortly after the river was blocked by sand, an Act of Parliament (22 Car. II) was obtained, in 1670 according to the House of Lords Record Office (Pers. comm. 2005), not 1669 as recorded by several authors. Although the main motivation for the Act was almost certainly the 1668 storm, we also need to consider some wider issues. In 1655, a pamphlet was published that argued the commercial and national benefits of creating a unified network of inland navigations, by improving rivers and by connecting them across watersheds by means of 'still' rivers (i.e. short canals). The connection between the Bristol Avon and the Thames was specifically identified. Fifteen years later, the same author repeated the substance of his earlier argument and added the proposal to link the Waveney and the Little Ouse to create an inland link from Yarmouth to Lynn and thence to York. He also noted the strategic advantage of internal communications in the context...
of the wars with Holland (Matthew 1655, 1670). These proposals accord with the consideration given in 1667 to opening a water link from the Cam to the Thames to supply London with coal from the north-east at a time when the sea passage was very hazardous, an abortive attempt having been made to do this in 1662 (Willan 1936, pp. 8–9, 120; see also Chisholm 2006).

The 1670 Act provided for the creation of two statutory navigations: on the Little Ouse from White House near Brandon Ferry to Thetford, and on the Waveney from Beccles to Bungay. There is no reference to the possibility of uniting these two navigations. In the Act, both rivers are described as having previously been navigable for ‘lighters keels and other boats of considerable burden’. But navigation had become impossible, necessitating expensive land carriage, on account of ‘blocking and sanding’. The reference to ‘sand’ presumably applies only to the Little Ouse, whereas ‘blocking’ would have been relevant for both. In the case of the Waveney, no prejudicial effects from draining the Fens would have been possible, and the implication is that the need for a statutory navigation arose on account of other reasons: neglect on both rivers, and the catastrophic blockage of the Little Ouse in 1668. Both rivers were to be made ‘passable with keels, lighters and other boats’.

The history of the Little Ouse navigation has been carefully documented by Clark in particular (Clark 1957; see also Crosby 1986, pp. 80–1). Initially, the Borough of Thetford took little action and then ceded the navigation rights to the Earl of Arlington in 1674. Under his jurisdiction, the river was cleaned and dredged, some straightening was carried out, particularly by cutting out the insides of bends, and weak banks were piled so that a halvingway could be constructed. In addition, weeds were cut as required on a seasonal basis. By the time Baskerville (1681, p. 271) recorded his travels, the navigation had been restored. This had been done without the construction of any flash locks or pound locks, which confirms that the impact of draining the Fens must have been minimal in lowering water levels and/or encouraging greater silting.

We do not know what size of craft could reach Thetford, but there is a clear presumption that nothing bigger than a lighter would have been possible. When the Earl died, his daughter assigned the navigation back to the Corporation of Thetford in 1696 as a going concern. The Corporation immediately leased the navigation to a tenant, and allowed it to deteriorate. Ultimately, it became necessary to introduce some engineering works, with the first lock—a flashlock or staunch—built at Thetford in 1742. All the other locks that were built subsequently were also staunches, not pound locks. The Thetford staunch had doors wide enough to accommodate lighters, indicating that these craft either were already reaching the head of navigation or would do so when the other staunches had been built. In addition, a noted Norfolk naturalist and antiquarian states that, for much of the river up to Thetford, the depth of water was about two feet (Clarke 1925, p. 97), which would limit cargoes to about 10 tons, compared with the 25 tons of a fully loaded lighter.

It will be recalled that Messrs Russel and Ruderham stated that, after Denver Sluice had been constructed, it was possible to bring only about four tons of freight to Thetford. Such a situation clearly existed for a few years, but on account of the 1668 sandstorm, and not because of Denver Sluice. It is equally clear that Dymond (1985, p. 235) was mistaken in believing that the 1670 Act was a direct consequence of the draining of the Fens.

**River Lark**

**Pre 1652**

The Lark is the smallest of the three tributaries for which a navigation Act was obtained within about 50 years of the completion of Denver Sluice. It is a narrow and shallow river, which has never been able to take large vessels. We know that Normandy stone was brought to Bury St Edmunds (henceforth Bury) via Lynn for ecclesiastical buildings in the twelfth century, and that the river was later the means for exporting woollen cloth (Bishop 1996, p. 80), Bury being an important centre for the East Anglian woolen industry. In the mid-fifteenth century, it seems that about one half of all exports from Bury went via Lynn, at a time when the Abbot, who had full control over all uses of the river, levied tolls on the barge traffic (Gottfried 1982, pp. 80, 92).

The comprehensive control over secular life exercised by the prelates came to an end with the dissolution of the monasteries in the sixteenth century, and it appears that the upper reaches of the river fell out of use as a navigation for want of regular maintenance: Bury became ‘dependent on road communications till the Lark was made navigable in the seventeenth century’ (Scarfe 1972, p. 188). However, below Mildenhall and Worlington the river was much used by the village of Isleham, via a cut leading to a hythe ‘which was flourishing in the sixteenth and seventeenth centuries’ (Oosthuizen 1993, p. 33).

That thoughts were turning to the problems of navigation on the Lark in the early seventeenth century is attested by a document held at the Suffolk Record Office in Bury St Edmunds. This is the draft of a Bill to be presented to Parliament in the early 1620s, though it appears that no action was taken (Suffolk Record Office c. 1621). As drafted, the intent was to cleanse, scour and shorten the river; to undertake the construction of locks, dams and other engineering works for the passage of boats; and to construct a halvingway. The vessels in question were to be ‘boats and cargo lighters’, plying from the Ouse to Bury. There was another abortive attempt in 1636, when Henry Lambe sought to establish a navigation from Mildenhall to Bury (Boyes & Russell 1977, pp. 178–9; Calendar of State Papers 1636, p. 386). According to Weston (1979, p. 2), the traditional head of navigation on the Lark was Worlington, a village downstream from Mildenhall.

At a time when Cambridge and Thetford enjoyed the benefit of navigable rivers in the absence of
engineering works, it is striking that attempts were made to make a formal navigation on the Lark. The implication is that this river was not navigable in its 'natural' state and could only be made so by significant expenditure, for which a source of revenue would have to be provided. That the upper Lark was not a traditional navigation in and before the seventeenth century is confirmed by the fact that Thetford lodged objections to Lambe's initiative, on the explicit grounds that Thetford would lose trade to Bury.

Consequently, when Badeslade writes of barges with about 13 tons getting 'as far in proportion up the rivers Mildenhall, Stoke etc.' we are to understand that Worlington (or possibly Mildenhall) was the head of navigation on the Lark, comparable to Thetford on the Little Ouse, and not Bury.

Post 1652

The Lark Navigation Act was obtained in 1698 (11 Gul. Ill c. 22). The preamble states that between Mildenhall and Bury the river was 'utterly impassable for boats lighters or other vessels', and that between Worlington and Mildenhall the river was 'very imperfectly navigable'. Consequently, the Act authorised Henry Ashley to make a navigation from Long-Common, a little below Mildenhall Mill, to Bury, and also to 'amend meliorate and improve' the passage of craft between Worlington and Long-Common. The right to levy tolls applied only to the formal navigation, i.e. from near Mildenhall Mill to Bury, and not downstream to Worlington. The inference is that the amount of work to be carried out below Mildenhall Mill was quite small, from which we may conclude that little if any adverse change had been occasioned by draining the Fens.

The Corporation of Bury would not permit the navigation to enter the town, with the result that the head of commercial operations terminated at Fornham St Martin, just beyond the boundary. The works were completed in or about 1715 (Weston 1979, p. 3) and were clearly of considerable benefit to Bury at the time of Defoe's travels in the early 1720s (Cole & Browning 1962, pp. 52–3). However, as Defoe notes, Bury had 'a very small branch of a small river'. Just how small can be seen from the width of the pound locks. The standard width was 11.5 feet, sufficient for a lighter. In the upper reaches of the navigation, the river was in some places so narrow that a staunch would occupy the full width of the channel, leaving no room for an adjacent weir: 'In such cases surplus water simply cascaded over the gates' (Faulkner 1977, p. 5).

It therefore seems that the navigation between Mildenhall and Bury had deteriorated to the point of impossibility long before the Earl of Bedford and Vermuyden set to work. Consequently, the 1698 Act is to be viewed as an attempt to rectify the long-standing deficiencies of the river, and not to remedy any problems arising from the Fen drainage.

Conclusions

River commerce on the Ouse between Denver and Earith and on the tributaries was not impeded by the seventeenth-century drainage works. If anything, conditions were probably improved, with greater reliability of water depth, something which is strongly suggested by the fact that the intended lock downstream from Ely was not in fact built because, we may infer, water levels could be managed by the regime adopted at Denver Sluice. In addition, the navigation Acts for the tributary rivers were not a response to the alleged prejudicial effects of the drainage works but reflected long-standing problems on the Cam and Lark, and the effect of a sandstorm in blocking the Little Ouse.

Given that conditions on the Ouse and its tributaries were not as good as Badeslade asserts that they were before 1652, and that thereafter navigation conditions were no worse than previously and probably somewhat better, why did Brandon and Thetford on the Little Ouse, Mildenhall and Bury on the Lark and the Corporation of Cambridge with respect to the Cam support Lynn in 1696 when the seaport petitioned Parliament for the removal of Denver Sluice?

Consider for a moment the impact of the New Bedford River on the Great Ouse at and above Earith. There is no doubt that the shorter route to the sea provided by the New Bedford River conferred considerable benefits on the navigation, with a marked reduction in freight costs (Summers 1973; Willan 1942; Wood 1992). In contrast, for the Ouse between Denver and Hermitage, it seems that, although there was no worsening of conditions occasioned by the drainage works, any improvement was comparatively small. Consequently, all the towns from Earith to Bedford gained a trade advantage relative to places on the Ouse and its tributaries between Denver and Hermitage, just below Earith. If Denver Sluice were to be removed and the New Bedford River abandoned, as Thetford, Bury and others wanted, then the commercially competitive situation would return to the pre-1652 position, to their relative advantage. This would not have been a persuasive argument to deploy in support of legislation to remove Denver Sluice, but may well have been the reason why other arguments and assertions were marshalled. This interpretation, which is supported by Lynne Turner (Pers. comm. 2005), would be consistent with the fact that, in 1696, the Dean and Prebendary of Ely Cathedral opposed Lynn's plea for Denver Sluice to be destroyed. The clergy's lands benefited from the drainage works and any disadvantage for navigation that there might have been was not sufficient to outweigh that advantage.

As for Lynn itself, it appears that opposition to Denver Sluice, and the drainage scheme as a whole, probably rested on perceptions regarding the navigability of the outfall below Denver — a highly dynamic environment — with the citizens of Lynn attributing any perceived worsening of conditions to a single cause, the changes associated with Denver.
Throughout most of England, the river navigations were superseded by canals in the eighteenth and nineteenth centuries. This did not happen in the Fens, where even small rivers remained commercially important until the advent of the railway. The catastrophic reduction in freight carriage that then occurred, as on the Cam (Chisholm 2003), implies that the rivers were less efficient than most canals, which were considerably more successful in retaining traffic. Despite the widespread belief that draining the Fens in the seventeenth century had a seriously detrimental effect upon river navigation, the rivers remained vital arteries of commerce for a further two centuries.

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Appendix

Keels as sea-going vessels?

There are some references in the literature to sea-going ships penetrating quite far inland, for example: 'sea-going craft of considerable tonnage' as far as Reach (Hughes 1909, p. 122; see also Paget-Tomlinson 1998a, p. 44). Wilson (1972, p. 5) is more explicit, saying that until 1649 keels could sail to Cambridge with 40 tons, these vessels being capable of carrying 100 tons when fully laden and that they probably originated from the Humber estuary. This information for Cambridge was accepted by Chisholm (2003, p. 184). Rather similar information is provided by Badeslade (1766, p. i), who states that keels with 40 tons could sail 36 miles up the Ouse towards Cambridge before Denver Sluice was built, though he does not say whether these vessels were sea-going or plied only on the rivers. In another reference to Cambridge, Seymour (1972, p. 251) says that, before Denver Sluice was built, ships from Newcastle with coal could annually make 18 round voyages to the town but that the number was reduced to 10–12 afterwards. And a quick reading of Jouvin (1672, p. 517) might leave the impression that the 'barques de la mer' that he noted were capable of negotiating the North Sea. The belief that quite large sea-going vessels could use the waterways before 1652 (which is reinforced by the crest which adorns the Guildhall in Cambridge), and that this became more difficult or impossible after the drainage works had been completed, so navigation in general was prejudiced, has gained considerable currency.

According to the Oxford English Dictionary, the term 'keel' did indeed apply to sea-going vessels but this usage died out after the sixteenth century (see also McGrail 2001, pp. 239–40). Among those who have written about them, there is clear agreement that along most of the East Coast keels were restricted to river and estuary work (Carr 1951; Clark 1972; Heslop 1901; McKee 1983; Murray 1901; Paget-Tomlinson 1993, 1998b, p. 28). This was certainly the case for the Tyne keels; dating back to the mid-fourteenth century, they carried coal down the river to the colliers, with loads which came to be standardised at about 21 tons. Likewise, the Norfolk keels were river craft. The Humber keels had to cope with comparatively open water, and Carr describes these vessels as capable of coastal work, though according to Paget-Tomlinson they rarely ventured to sea. There was no specifically identified fenland version of the keel.

The standard Humber keels were very similar to medieval coasters. They were about 62 feet long, 15.5 feet in the beam and drew seven feet when fully laden (Carr 1951, p. 142 ff.). They were square rigged, and the masts could be lowered. Therefore, in principle they could pass under bridges and as a consequence could sail up river. Whether they were in fact able to pass under the five bridges that existed on the Ouse before 1652 between Lynn and what became known as Denver Sluice (Dugdale 1772, map facing p. 375) is uncertain. It is known that Downham Bridge existed in 1454, Stow Bridge in 1550 and Magdalen Bridge in 1582 (Norfolk Record Office 1890). As late as 1890, the spans of Stow Bridge were no more than 33 feet, so the earlier structures almost certainly afforded even narrower passages for boats. Furthermore, a sea-going vessel that could carry 100 tons when fully loaded would ride high in the water when carrying a part load of 40 tons, and it is known that the much smaller lighters, with a freeboard of only six inches, could be held up at spring tides for the want of headroom at the bridges (Stewart 1909, p. 104).

It seems unlikely that the Humber keels were seen very often at Lynn and equally unlikely that they could then sail up the Ouse. Consequently, it is probable that the term keel as used on the fenland waterways is derivative from the Tyne keels, not because these vessels made the passage southwards, but because the coal trade was very important on the fenland rivers, with the result that the term keel was applied to the flat-bottomed craft that were engaged in the coal trade.

There are further reasons for being sceptical about sea-going vessels penetrating inland to Cambridge and elsewhere. In the sixteenth and early seventeenth centuries, the overseas and coastal trades of ports were closely controlled by the Crown to ensure that the relevant dues were paid. The detailed procedures
are well described by Hinton (1956, pp. xiv–xvii). All incoming goods had to be unloaded under supervision, with equivalent provisions for outward bound cargo. Only the port’s merchants could handle transactions. Conforming to these rules, all freight arriving at Lynn had to be unloaded, either from one vessel to another, or to land (Barney 1997, Parker 1971, p. 112). If the goods were destined up river in a sea-going vessel, then they would have to be re-loaded. This double handling, plus operating with a part load in the restricted circumstances of a river, means that the economics of inland navigation for sea-going craft must have been questionable.

That keels were in fact used solely on inland waters in the fenland context in 1566 is strongly suggested by the record in that year of 14 vessels at Wisbech, being ‘keles barges botes and lighters’ engaged in the carriage of grain and coal, operated by watermen who ‘are no maryners or fflyshermen’; none of these vessels exceeded 12 tons burden. The same source records the ‘few keels, lighters and barges’ at Ely, which are then described as the three barges (Elye et al. 1909, pp. 94–5). There is a fourteenth-century record in Latin of corn being shipped from Cambridge to Lynn in ‘keles’ and from there in ‘naves’ to destinations beyond (Owen 1984, p. 258). The same source describes Lynn’s trade as that of an entrepot, with other early records of keels that point to their use only on rivers and estuaries. The keels that were owned in the fifteenth and sixteenth centuries by inhabitants of Reach (VCH 2002, p. 225) almost certainly did not venture beyond Lynn.

Doubt regarding the possibility that sea-going vessels sailed up river to places like Reach and Cambridge is reinforced by the evidence contained in the Inventory published by the Royal Commission on Historical Monuments (RCHME 1972). At Reach, six basins are identified, the dates of which are unknown. Two of these are 20 feet wide, and the other four only 15 feet, dimensions that imply that only quite small craft could have ever negotiated the lode. A similar situation obtained at Burwell, where the Hythe was bounded on both sides by watercourses that were no more than 20 feet wide, with the additional complication that access thereto required a right-angle turn from the lode into the Weirs and another to come alongside the Hythe. Access to Commercial End at Swaffham Bulbeck also involved two right-angle bends, until the New Cut was made shortly after 1821. The lode is shown on the 1926 Ordnance Survey plan (scale 1:2500 or 25 inches to the mile) as being about 20 feet wide, with a turning point near the Merchants House which would have limited the length of vessels to less than 40 feet, more probably 35 feet at the most. At all three settlements, the configuration of the waterways strongly implies use by nothing bigger than barges or lighters at any time, including the early seventeenth century.

There is some suggestion that keels were the bigger craft on the inland waterways, with lighters and barges being terms used for smaller vessels. However, some care is needed in drawing this conclusion. None of the 1566 Wisbech craft exceeded 12 tons, nor were any of the vessels at Ely larger than eight loads (about eight tons). The Tyne keels carried about 21 tons, and the standard lighters on the fenland waterways after the seventeenth century carried 25 tons. But there will have been considerable variation in vessel sizes, as shown by a late eighteenth century Norfolk register of inland craft exceeding 13 tons burden (Norfolk Record Office 1795). Working the rivers from Great Yarmouth, the median size for keels was 60 tons, with the maximum and minimum being 97 and 20 respectively. The equivalent figures for wherries were: median 24, maximum 50 and minimum 14, while the three craft identified as boats carried no more than 16 tons each. Unfortunately, the equivalent information for Lynn has not survived (S Maddock Pers. comm. 2005). In the fenland context in the seventeenth century, it is probable that the terms ‘keel’, ‘lighter’ and ‘barge’ all refer to flat-bottomed estuarine and river craft, and that the terms might have signified the mode of construction – shape, whether clinker or carvel built, the configuration of sail and rigging – and also the cargo carried, with keels prominent in the coal trade and tending to be the larger craft. Barney (1997, pp. 221–2) is right in stating that sea-going craft did not ply the fenland waterways.

**Loads, chaldrons and tons**

In the literature about the fenland, cargo is measured as loads, chaldrons or tons, and it is clearly necessary to be able to convert to a common unit of carrying capacity: the long ton of 2240 pounds.

The chaldron was the unit used in the coal trade along the East Coast, but itself had different values. The wholesale coal trade in Lynn used chaldrons of 1.275 tons (Barney 1997), whereas the retail trade up the Ouse was conducted in chaldrons of 1.33 tons (Nef 1932 vol. 2). Rounded to the nearest decimal place, both chaldrons can be equated to about 1.3 tons.

The load was used for a wide variety of goods, with different definitions for what it comprised. Consequently, there is no generally agreed weight equivalence for a load of cargo (Oxford English Dictionary; Britten 1880; Zupko 1977). Fortunately, early navigation Acts generally specified the maximum charge that could be levied on the various commodities, from which it is clear that for navigation purposes one load was equated to one ton. For example, the 1702 Act for the Cam specified a toll of one shilling for a ‘load or ton’ of timber, and also for a load of hay defined as 20 hundred [weight]. Similar equivalents are found for the Little Ouse, the Lark, part of the Great Ouse and more generally (see Priestley 1969). For the purpose of this paper, one load has been taken to be about 1.0 ton.

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Endnotes

1. There is some doubt about the precise year in which the tides on the Ouse were stopped by Denver Sluice and the sasse or lock which it incorporated. Harris (1953, p. 132) states that the sluice 'was constructed first in 1651', but Frances Willmoth (Pers. comm. 2007) has pointed out that this may be too early. She notes that the company's minutes for 8 December 1653 record an order to Moore as the Surveyor, that he should 'have a vigilant Eye to the double sasse at Salters Lodge and the sluices at Stow that noe evill disposed persons may prejudice the same while the businesse touchinge navigation is here above dependinge' (CRO 1652–6). So we know that the sasse existed at the end of 1653, but we may also be confident that it must have been completed perhaps 12 months previously, for the following reason. In March 1651, the North and Middle Levels had been declared successfully drained, and on 17 February 1653 Vermuyden submitted a memorandum declaring that the main works in the South Level had been finished and were fit for adjudication; Denver Sluice was part of the South Level works. In March 1653, the whole drainage project was declared to have been successfully accomplished and there was a service of thanksgiving in Ely on the 28th of that month (Skempston et al. 2002, p. 746). Additional works at Denver were not completed until 1656: 'a Sluice and Clow by the great Sasse neare Salters Loade' (CRO 1654–5).

The implication of Vermuyden's successful deposition is that the sasse across the Ouse at Denver had been completed by late 1652 or very early in 1653, and for this paper the earlier year has been taken to mark the end of tidal conditions on the Ouse above Denver, with vessels using the lock provided.

2. The 1670 Little Ouse Act was not printed and is therefore not readily available; it is also difficult to read. The version used is a transcript held at the Norfolk Record Office, catalogued as T/01/12, of which the author has a photographic copy; copies thereof have been deposited at the following Record Offices: House of Lords, Cambridge, Bury St Edmunds and Norwich.